Center Innovation Fund: LaRC CIF

Computational Design of Ageless Structural Materials

Completed Technology Project (2013 - 2015)

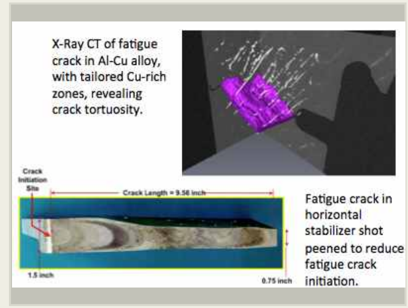
Project Introduction

The focus of this project is to link microstructure, mechanical performance, and processing of additively manufactured titanium alloys. Ultimately, linking such material attributes would permit alloy design (e.g., mechanical performance) by prescribing alloy composition and processing parameters.

Historically, the structural optimization of aerospace components has been done through geometric methods. A monolithic material is chosen based on the best compromise between the competing design limiting criteria. Then the structure is geometrically optimized to give the best overall performance using the single material chosen. Functionally graded materials offer the potential to further improve structural efficiency by allowing the material composition and/or microstructural features to spatially vary within a single structure. Thus, local properties could be tailored to the local design limiting criteria. Additive manufacturing techniques enable the fabrication of such graded materials and structures. This paper presents the results of a graded material study using two titanium alloys processed using electron beam freeform fabrication, an additive manufacturing system. The results show that the two alloys uniformly mix at various ratios and the resultant static properties of the mixed alloys behave according to rule-of-mixtures. Additionally, the crack growth behavior across an abrupt change from one alloy to the other shows no discontinuity and the crack smoothly transitions from one crack growth regime into another.

Anticipated Benefits

This technology would simultaneously allow development of higher-performing alloys and permit more efficient use of materials.



Project Image Computational Design of Ageless Structural Materials

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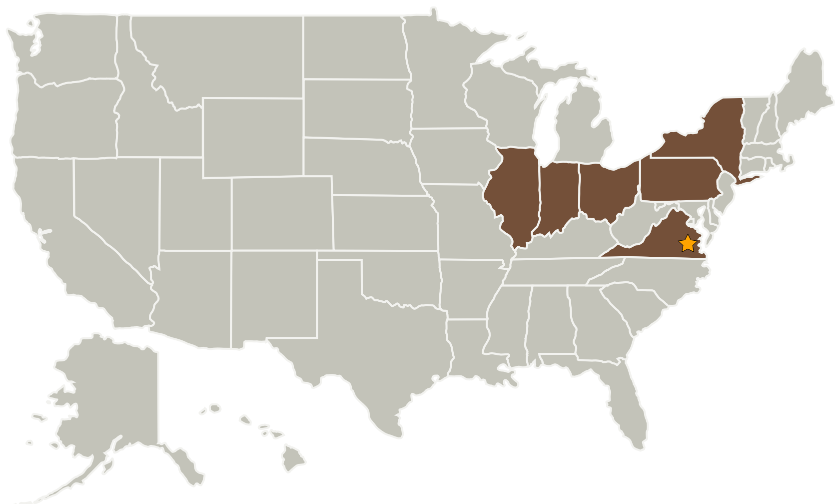
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia

Co-Funding Partners	Type	Location
Air Force Office of Scientific Research(AFOSR)	US Government	Arlington, Virginia
Cornell University	Academia	Ithaca, New York
HDF Group	Industry	
Purdue University-Main Campus	Academia	West Lafayette, Indiana

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Center Innovation Fund: LaRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Julie A Williams-byrd

Project Manager:

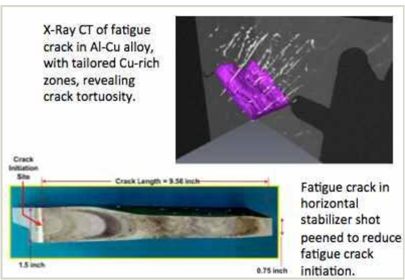
John A Newman

Principal Investigator:

John A Newman

Primary U.S. Work Locations	
Illinois	Indiana
New York	Ohio
Pennsylvania	Virginia

Images



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Project Image Computational Design of Ageless Structural Materials
(https://techport.nasa.gov/image/2288)

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **3**

1 2 3 4 5 6 7 8 9

Applied Research | Development | Demo & Test

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └ TX12.1 Materials
    └ TX12.1.8 Smart Materials